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Martelli

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(54) **ENGINE-GEARBOX ASSEMBLY, IN PARTICULAR FOR MOTORCYCLES**

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(52) **U.S. Cl.** **477/107**; 477/79; 477/87; 74/335
(58) **Field of Search** 477/107, 79, 80, 477/81, 83, 84, 85, 86, 87, 110

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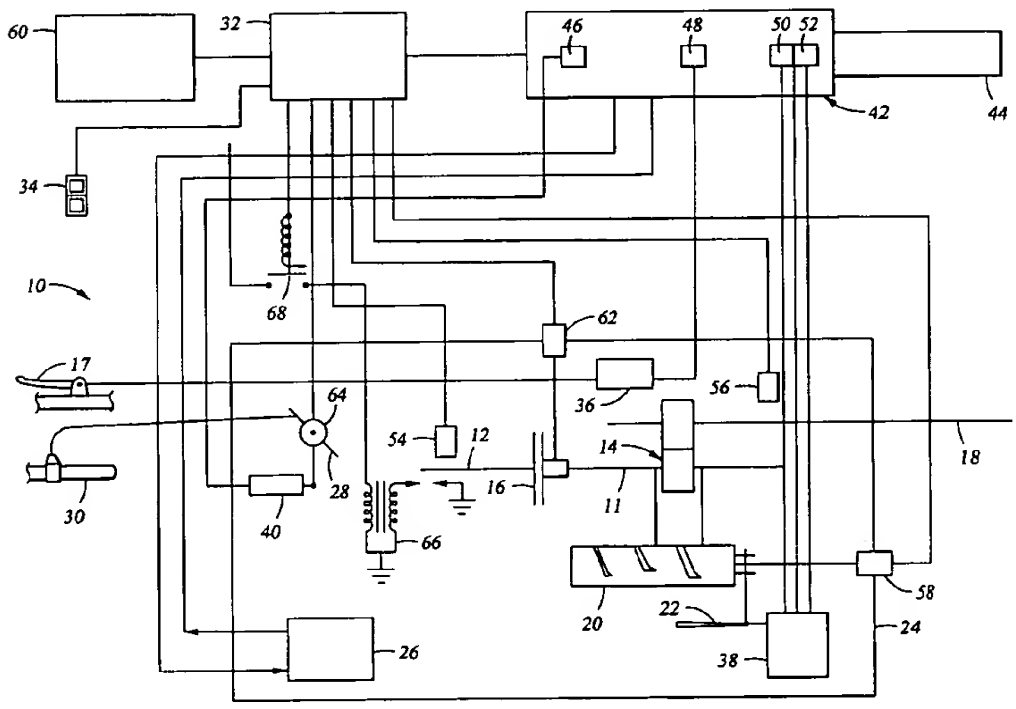
(57) **ABSTRACT**

An engine-gearbox assembly includes manual control (**17**, **22**) for controlling the operation of a friction clutch (**16**) and the engagement of gears, and actuators (**36**, **38**) for controlling, in a servo-assisted manner, the operation of the friction clutch (**16**) and the engagement of the gears independently from manual control (**17**, **22**). An electronic control unit (**32**) is provided for controlling the actuators as a function of a command imparted by the driver.

8 Claims, 3 Drawing Sheets



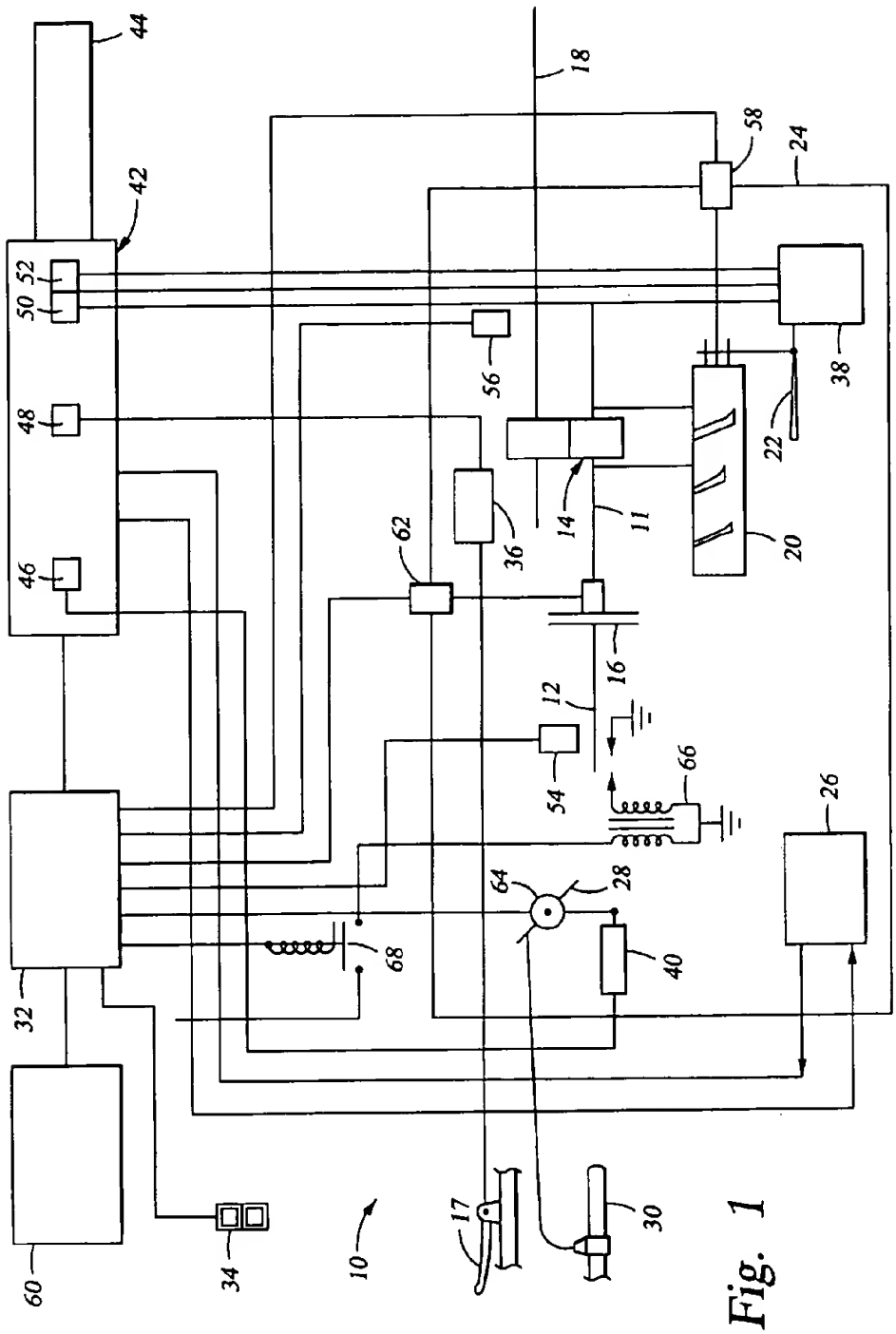

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Fig. 1

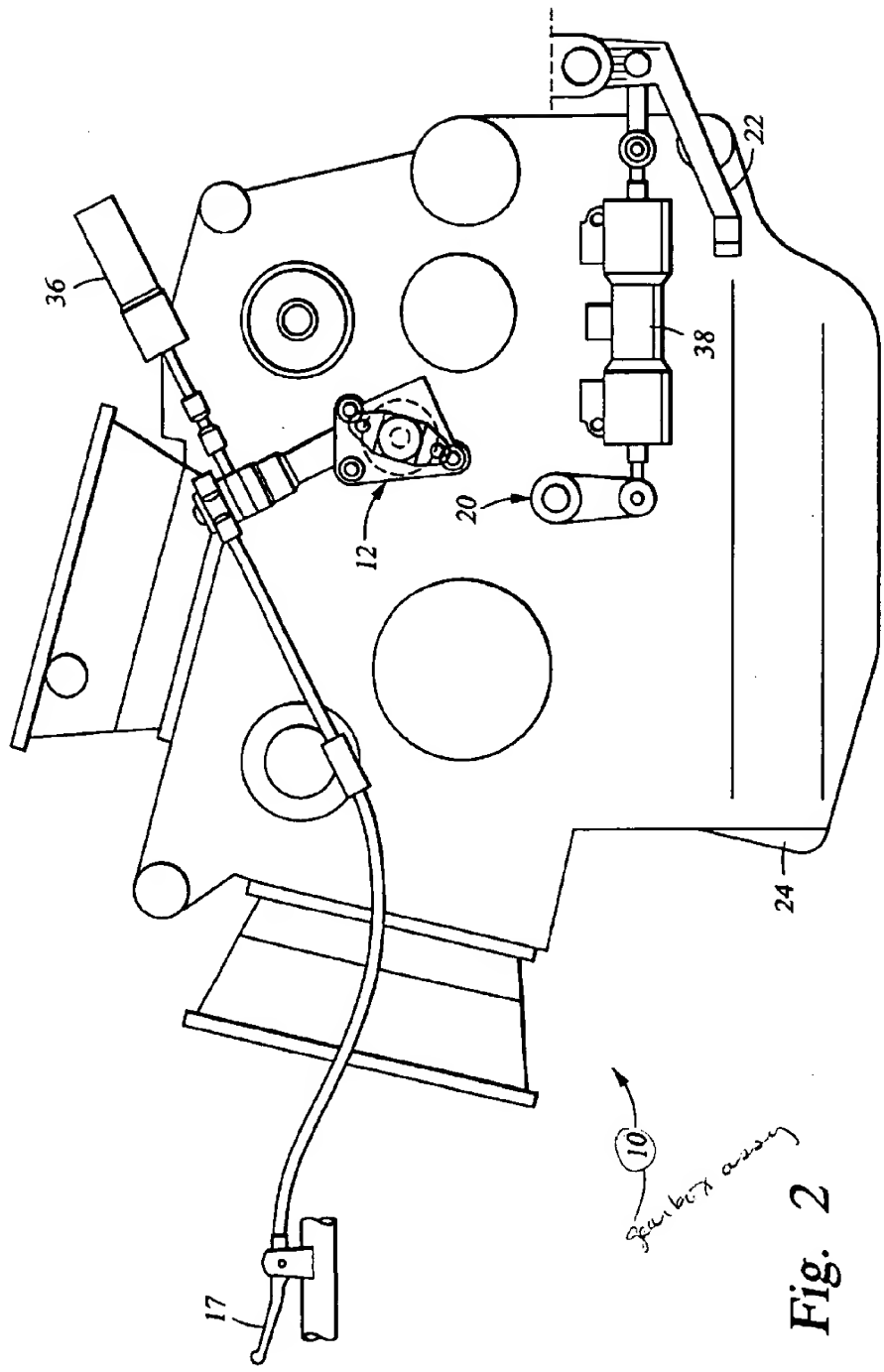
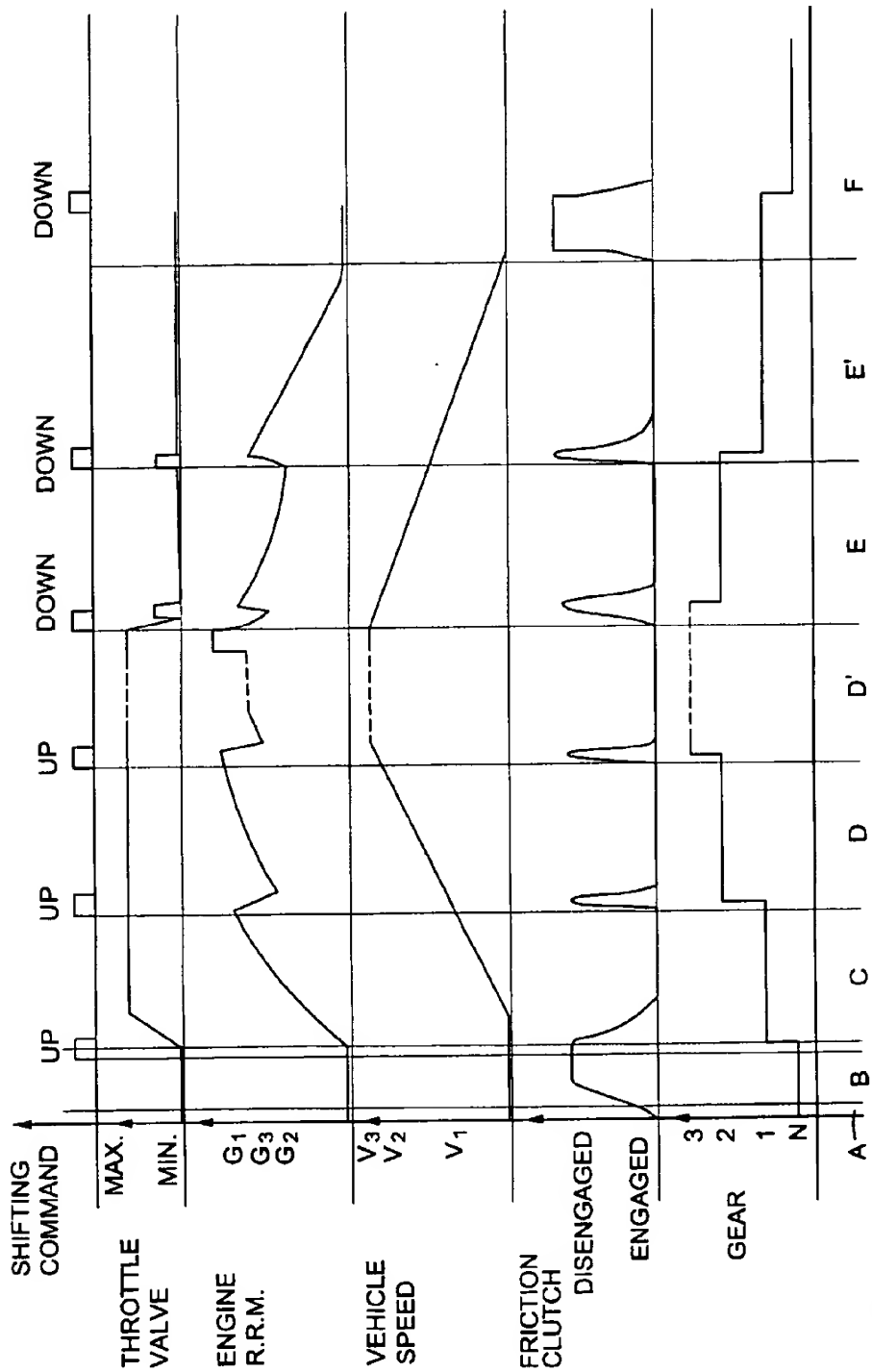


Fig. 2


SHIFTING COMMAND
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UP
UP
DOWN
DOWN
DOWN
A
B
C
D
D'
E
E'
F
THROTTLE VALVE
MAX.
MIN.
ENGINE R.R.M.
G1
G3
G2
VEHICLE SPEED
V3
V2
V1
FRICTION CLUTCH
DISENGAGED
ENGAGED
GEAR
3
2
1
N

Fig. 3

ENGINE-GEARBOX ASSEMBLY, IN PARTICULAR FOR MOTORCYCLES

The present invention relates to an engine-gearbox assembly, in particular for motorcycles. Motorcycles are generally provided with a sequential non-synchronised gearbox. In traditional solutions, the members which intervene during a shifting operation are generally three: a hand grip for controlling the flow of fuel to the engine, a friction-clutch control lever and a pedal for selecting the gears.

The engine-gearbox assembly according to the present invention is characterized in that it comprises, in addition to the traditional manual control means, actuator means for controlling the operation of the friction-clutch and engagement of the gears, independently from the manual control means. An electronic control unit is provided for controlling said actuator means for shifting in a servo-assisted manner after having received a shifting command imparted by the driver, for instance by means of a pair of push-buttons.

With an assembly according to the present invention, the driver can carry out the shifting either in a servo-assisted manner by simply pushing a button, or in a manual manner by using the friction-clutch lever, the gas control hand grip and the pedal for selecting the gears, as in a normal motorcycle with manually-controlled gear shift.

Characteristics and advantages of the present invention will become clear in the course of the detailed description which follows, given purely by way of non-limiting example, with reference to the attached drawings, in which:

FIG. **1** is a block diagram of an engine-gearbox assembly according to the present invention,

FIG. **2** is a diagrammatic lateral view of an assembly according to the invention, and

FIG. **3** shows a series of diagrams showing different operative parameters of the engine during a sequence of gear shiftings.

FIGS. **1** and **2** show schematically an engine-gearbox assembly for a motorcycle, indicated at **10**. The assembly **10** comprises, in a way per se known, a crankshaft **12** which is connected to a gearbox schematically indicated at **14** by means of a friction clutch which is operated by a lever **17** placed on the handlebar of the motorcycle. The output shaft of the gearbox **14** is indicated at **18**. The gearbox **14** is a sequential gearing which, in a way per se known, is operated by a rotatable cylinder **20** on which double-effect cams are formed which sequentially change the selected gear as a function of the angular position of the cylinder **20**. A pedal **22** can be operated in a traditional way for varying the angular position of the cylinder **20** and consequently shifting gear. The friction clutch **16** and the gearbox **14** are enclosed in a box **24** together with a gear pump **26** which, driven by the engine, feeds the hydraulic circuit of the internal combustion engine with lubricating oil.

In a fully conventional way, the engine is provided with a throttle valve **28** which controls the immission of the combustible mixture. The throttle valve **28** is controlled by a hand grip **30** placed on the handlebar of the motorcycle.

The gear selection pedal **22**, the friction control lever **17** and the gas hand grip **30** represent manually operated control means for shifting gears in a traditional motorcycle.

In accordance with the present invention, the engine-gearbox assembly **10** comprises, in addition to the previously disclosed manual control means, a series of actuators, preferably hydraulic, which enable the gear shifting to be carried out in a servo-assisted manner in the way which will be disclosed in the following. The servo-assisted gear shifting is controlled by an electronic control unit **32** which

receives a gear shift command form a pair of push-buttons **34**, preferably placed on the handlebar, through which the driver imparts either up-shifting or down-shifting commands.

A first hydraulic actuator **36** is provided for operating the friction clutch **16** independently of the manual control lever **17**. A second hydraulic actuator **38** is provided for rotating the cylinder with double-effect cams **20** and a third hydraulic actuator **40** is provided for varying the position of the throttle valve **28** independently from the position imparted by the manual hand grip **30**. Therefore, the clutch **16**, the gear box **14** and the throttle valve **28** can be indifferently actuated either manually or in a servo-assisted manner.

A hydraulic control unit **42** comprises an accumulator **44** and a plurality of electric valves **46**, **48**, **50** and **52**, controlled by the electronic control unit **32**. In accordance with a particularly preferred embodiment of the present invention, the hydraulic circuit which controls the actuators **36**, **38** and **40** uses as a control fluid the same oil used for lubricating the engine. The gear pump **26** is used for producing the pressurised oil flow necessary for feeding the hydraulic actuators **36**, **38** and **40**. The electric valve **46** feeds the actuator **40** which operates a control lever which rotates the throttle valve for increasing the flow of combustible mixture with respect to the quantity set by means of the manual hand grip **30**. The electric valve **48** is of a type either with proportional flow rate or proportional pressure and feeds the actuator **36** which controls engagement and disengagement of the friction clutch **16** independently from the position of the manual lever **17**, as disclosed in detail in a contemporaneous patent application of the same applicant. The electric valves **50** and **52** feed the double-effect actuator **38** which is moved in a first direction for up-shifting and in the opposite direction for down-shifting.

The engine-gearbox assembly according to the present invention is also provided with two speed sensors **54**, **56** which send to the electronic control unit **32** signals indicating the rotational speeds of, respectively, the crank shaft **12** and the gearbox output shaft **18**. A sensor **58** sends to the electronic control unit **32** a signal indicating which gear is engaged and this information is displayed on a display **60** placed on an instrument panel. A sensor **62** for detecting the operative state of the friction clutch **16** (engaged/disengaged) and a sensor **64** for detecting the aperture angle of the throttle valve **28** are also provided.

The electronic control unit **32** can also be programmed for temporarily interrupting the power supply to the ignition coil **66**, for instance through a relay **68**, or by sending an interruption command to an engine control unit, for reducing the speed of rotation of the engine during up-shifting.

The diagrams of FIG. **3** explain the operation of the system according to the invention and show for some characteristic operating phases, indicated A, B, C, D, D', E, E' and F the variation of the main characteristic parameters of the system, constituted by selected gear, state of the friction clutch, speed of the vehicle, engine r.p.m., position of the throttle valve, and shifting command.

The phase A represents a starting situation in which the vehicle is stationary in neutral, engine idling and throttle valve in idling position. The friction clutch is engaged and there is no shifting command. Starting from this situation, in phase B the friction clutch is manually disengaged and the up-shifting push button is depressed (shifting command "up"). At the end of the phase B the friction clutch is disengaged, the throttle valve and the engine are idling and the vehicle is still stationary. The first gear has been engaged in a servo-assisted manner.

During the phase C, the throttle valve is moved, for instance, from the idling position to a full-gas position though a rotation of the hand grip **30** and the engine r.p.m. raises progressively to the value G1. By progressively engaging the manually operated friction clutch, the speed of the vehicles raises and at the end of the phase C the system is in a situation in which the first gear is engaged, the friction clutch is engaged, the speed of the vehicle has reached a certain value V1 and the engine r.p.m. has reached a value G1. It has been supposed that in the following phase D the position of the throttle valve is maintained constant, for instance in the position of full-gas, and an upshifting command is imparted. The electronic control unit **32** reacts to the shifting command by disengaging in a servo-assisted manner the friction clutch and by inserting also in a servo-assisted manner the upper gear. Preferably, the electronic control unit **32** reduces the engine r.p.m. before inserting the upper gear. This can be obtained for instance by temporarily switching-off the power supply to the ignition coil **66** through the normally closed relay **68** or by sending a suitable command to an ignition control unit. This determines a reduction of the engine r.p.m. from the value G1 to the value G2.

After having inserted the upper gear, the friction clutch is progressively engaged in a servo-assisted manner and the engine r.p.m. and the speed of the vehicle raise progressively. The same sequence is repeated in a similar manner in the phase D' where, after a further "up" command, a further up-shifting occurs from the second to the third gear and the vehicle reaches the speed V3.

Now we will suppose that the vehicle is travelling at a speed V2 with the third gear engaged and with the gas hand grip (throttle valve) in the full-gas position (phase D') and the driver wishes to down-shift in a servo-assisted manner. In the phase E, the driver manually reduces the degree of aperture of the throttle valve, for instance by bringing to the idle position the gas hand grip, and sends a "down" command for down-shifting to the immediately lower gear. The engine r.p.m. is reduced as a consequence of the closure of the throttle valve. In this phase, it is preferable to accelerate the engine for bringing its speed of rotation at an optimal value for the engagement between the primary shaft of the gearbox **11** and the engine crank shaft **12**, for preventing locking of the motorcycle rear wheel when the friction clutch is re-engaged. This is obtained in an automatic manner by the actuator **40** which determines the degree of aperture of the throttle valve. An increase of the angle of aperture of the throttle valve is automatically obtained and the engine r.p.m. raises to the value G3. At the same time, the actuators controlling the friction clutch and the gearbox disengage the friction clutch and engage the immediately lower gear. The same sequence is repeated in the phase E' for passing from the second gear to the first gear.

Finally, the phase F represents the phase in which the driver switches to neutral and stops the vehicle using the servo-assisted gear shifting function. For proceeding in this way, the driver manually sets to idling the position of the throttle valve and disengages manually the friction clutch by pulling the lever **17**. By imparting a "down" shifting command in the situation in which the throttle valve is in the idling position and the friction clutch is disengaged, the control unit **32** puts the gear box in neutral position N.

In any moment the driver can decide whether to use the servo-assisted shifting by acting on the push-buttons **34** or the traditional manual sequence involving the use of the friction lever **17**, the gas hand grip **30** and the gear selection pedal **22**.

What is claimed is:

1. An engine gear box assembly for a motorcycle, comprising:

a friction clutch;

at least two gears;

a throttle valve;

manual control means for the clutch, gears and valve;

an electronic control unit to selectively operate the clutch, gears and valves in an automated fashion; and

a plurality of hydraulic actuators for controlling each of said clutch, gears and throttle valve.

2. The assembly of claim **1**, whereby the hydraulic actuators are controlled by a hydraulic control unit.

3. The assembly of claim **2**, whereby the hydraulic control unit includes an accumulator and a plurality of electric valves.

4. The assembly of claim **2**, whereby the hydraulic control unit is controlled by the electronic control unit.

5. The assembly of claim **1**, wherein the actuators are operated with lubricating oil from an engine of the motorcycle.

6. The assembly of claim **2**, further including sensors to sense at least one condition related to each of the clutch, gears and throttle valve, the sensors relaying information to the electronic control unit.

7. The assembly of claim **1**, wherein the electronic control unit is programmed for reducing the speed of rotation of the engine before engaging an upper gear.

8. The assembly of claim **1**, wherein the electronic control unit is programmed for increasing the speed of rotation of the engine before engaging a lower gear.

* * * * *

US005080207A

United States Patent [19]

Horneffer

[11] Patent Number: 5,080,207

[45] Date of Patent: Jan. 14, 1992

[54] SERVO-ASSISTED GEAR SELECTOR

[75] Inventor: Franz Horneffer, Meckenbeuren, Fed. Rep. of Germany

[73] Assignee: Zahnradfabrik Friedrichshafen AG, Friedrichshafen, Fed. Rep. of Germany

[21] Appl. No.: 458,675

[22] PCT Filed: Jun. 22, 1988

[86] PCT No.: PCT/EP89/00578

§ 371 Date: Jan. 17, 1990

§ 102(e) Date: Jan. 17, 1990

[87] PCT Pub. No.: WO89/00515

PCT Pub. Date: Jan. 26, 1989

[30] Foreign Application Priority Data

Jul. 22, 1987 [DE] Fed. Rep. of Germany 3724272

[51] Int. Cl.[5] B60K 41/22

[52] U.S. Cl. ..... 192/3.63; 192/30 W

[58] Field of Search ..... 192/3.63, 30 W

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Primary Examiner—Allan D. Herrmann

Assistant Examiner—Nicholas Whitelaw

Attorney, Agent, or Firm—Herbert Dubno

[57] ABSTRACT

Servo-assisted gear selection for a vehicle gearbox and gear change controlled by the driver by actuating the clutch, wherein the driver is informed of the selection having been performed in the gearbox by a haptic or tactile signal at the clutch pedal. The signal is transmitted mechanically from an electromagnet to the clutch pedal, or the electromagnet is arranged in the pedal plate of the clutch pedal. The signal generator may also consist of an electromagnet in conjunction with a pressure piston, which acts on the pressure line of the clutch actuating mechanism, or of an electropneumatic valve in conjunction with a differential piston signal generator.

10 Claims, 3 Drawing Sheets

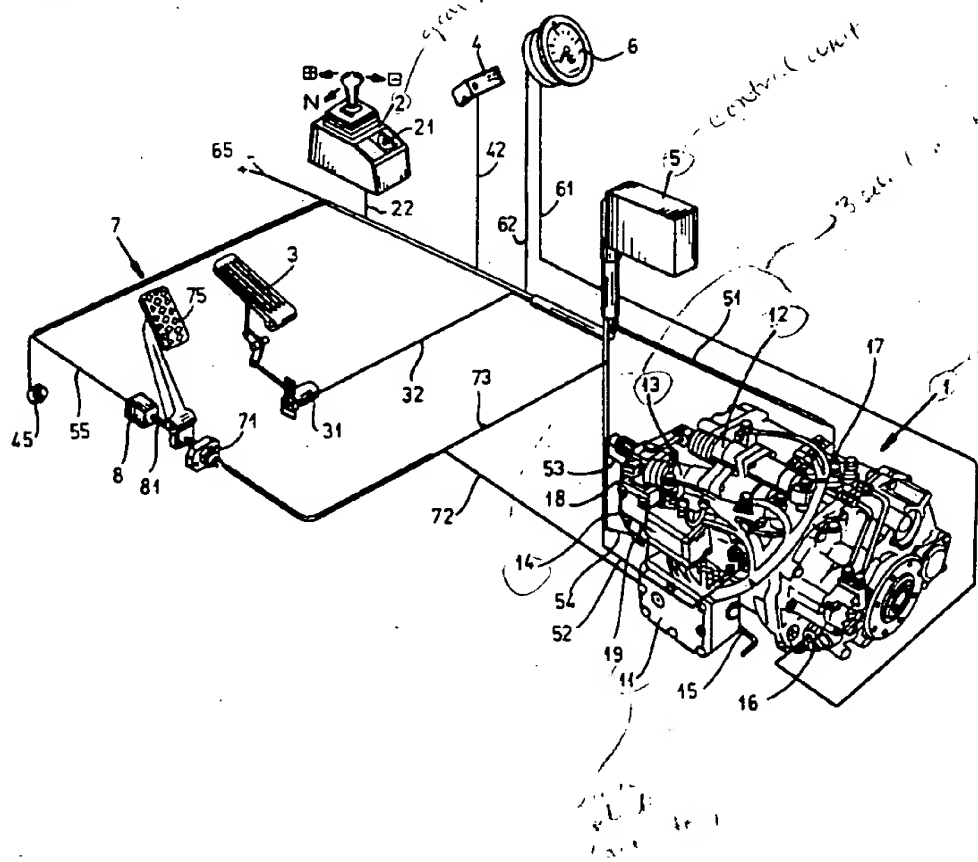
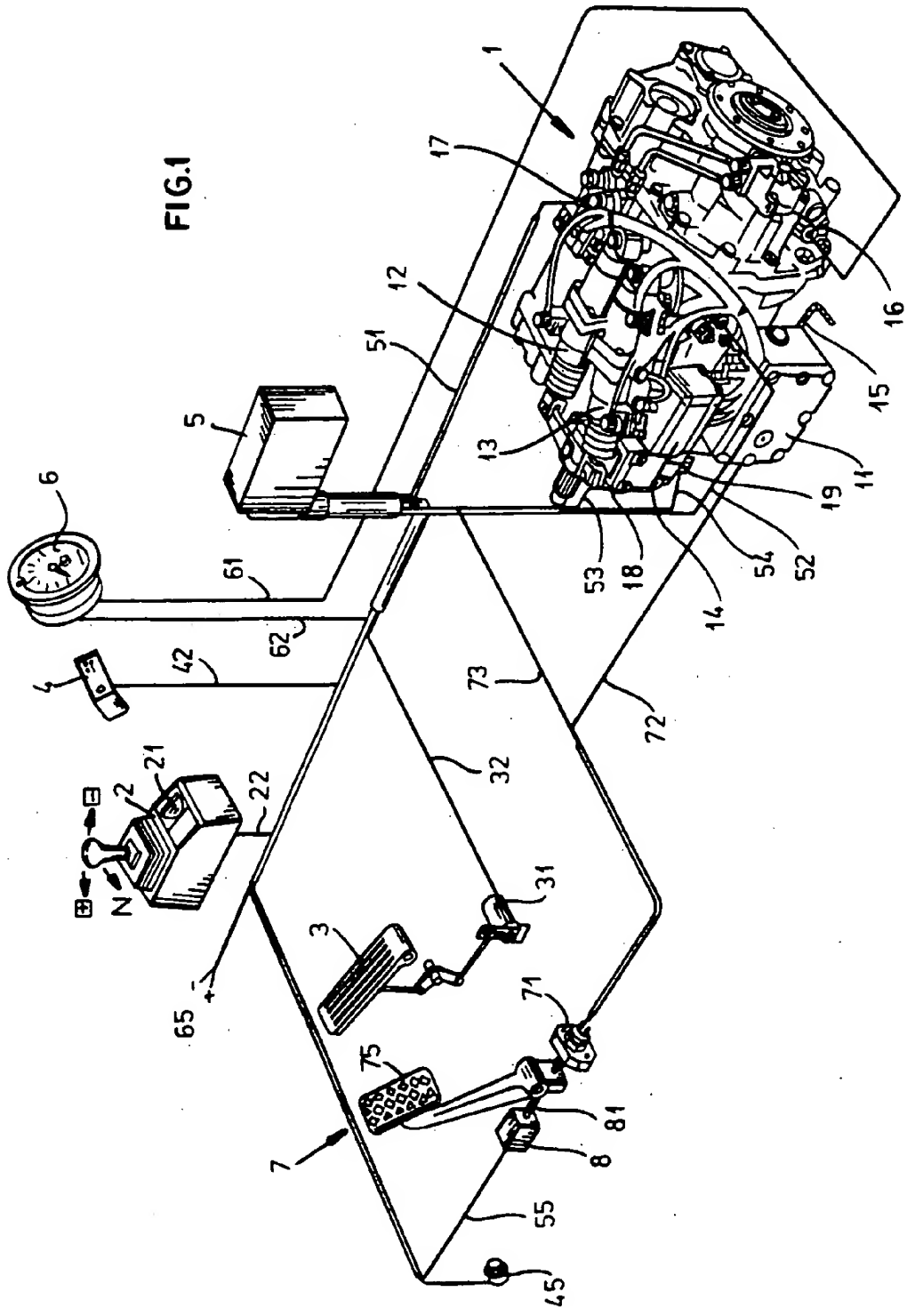


FIG.1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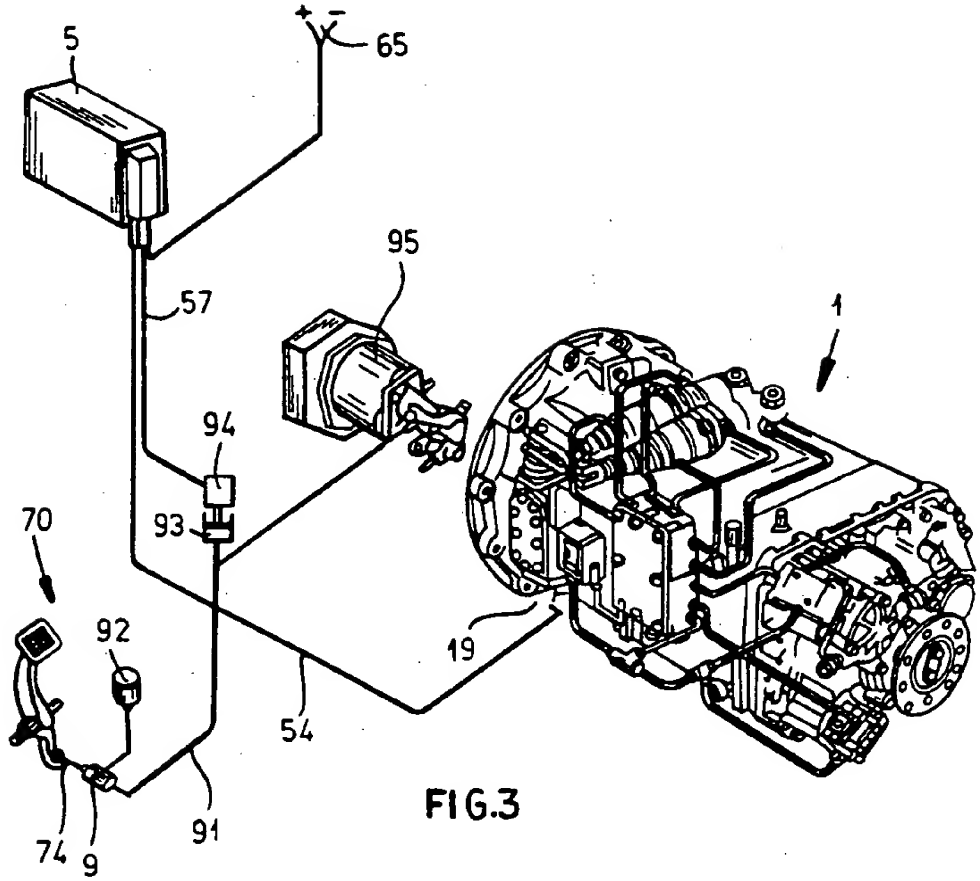

FIG.3

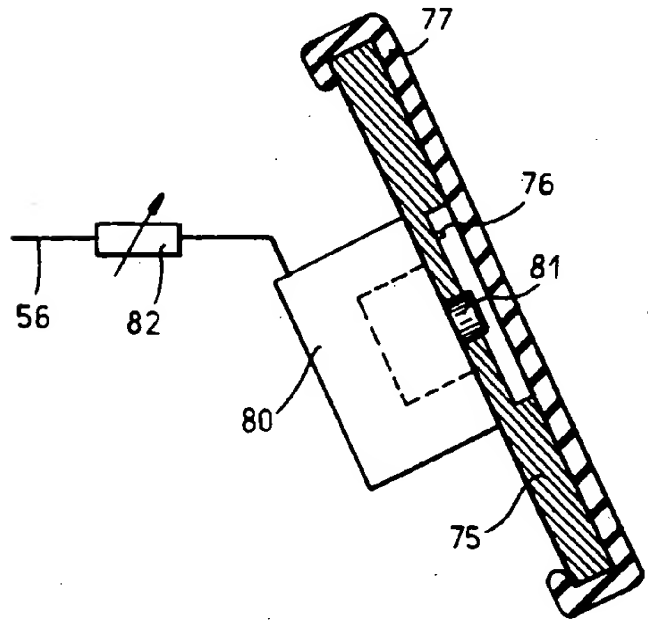

FIG.2

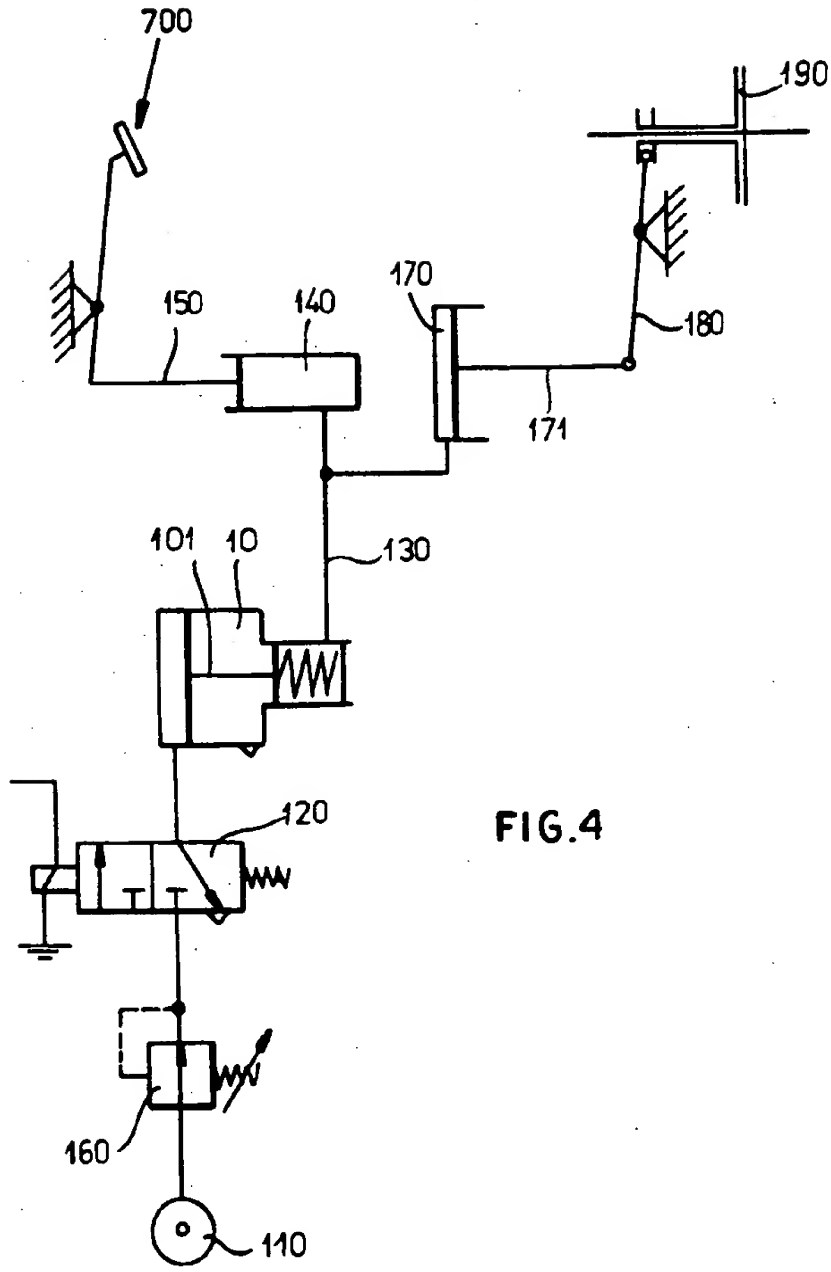

FIG.4

SERVO-ASSISTED GEAR SELECTOR

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a national phase of PCT/EP88/00578 filed June 30, 1988 based upon German National application P 37 24 272.5 of July 22, 1987 under the International Convention.

FIELD OF THE INVENTION

The present invention relates to a servo-assisted gear selector for vehicle gearboxes with gear preselection and gear change controlled by the driver by actuating the clutch at the clutch pedal and wherein the driver is informed of the selection performed in the gearbox by a signal.

BACKGROUND OF THE INVENTION

Such gear selectors, in which the driver or an electronic device merely selects the gear, and the gear change is performed in the gearbox proper by a servo-assisted actuating device rather than directly by the driver via a shifting linkage, have been known in many designs, e.g.,

- ZF [Zahnradfabrik Friedrichshafen AG] Specification for electropneumatic selection (ES) for synchromesh transmissions F 43546/RT 3430-885,
- ZF specifications for automated preselector (APS) for synchromesh transmissions F 32437/RT 3431-885.
- electronic-pneumatic selector EPS for trucks of Daimler Benz Aktiengesellschaft, Order No. 6510302300 of March 1986,
- Scania - Leichter schalten mit Computer (Shift more easily by a Computer), page 4, column 2, paragraph 2.

In all these designs, the clutch and consequently the drive train between the engine and the gearbox is disengaged and engaged, as before, by the driver via the clutch pedal by the driver. While in the case of gear selection via a shifting linkage, the driver recognizes when the gear has been selected as a consequence of the direct contact with the shifting means in the gearbox, this information, which is generated in conjunction with the actuation of the gear shift lever and the shifting linkage, is lacking in the case of a servo-assisted gear selector. To ensure properly timed actuation of the clutch, especially for engaging the clutch after completion of the selection in the gearbox, a corresponding feedback must be generated in order to again engage the drive train disengaged via the clutch shortly after completion of the selection process in the gearbox.

It is known from the first-mentioned ZF publication for an electropneumatic selector (ES) that the corresponding gear can be selected with the lever of the gear selector. A noticeable restoring force acts against the selection movement, and this force is abolished as soon as the gear selected in the gearbox is thrown in. The lever can now be moved easily into the end position. This also represents a signal for re-engagement for the driver.

In the automated preselector (APS) according to the second ZF publication, the feedback on completion of the selection is an acoustic feedback generated by a buzzer, page 2, column 2, paragraph 1. This also represents the signal for re-engagement for the driver. According to the EPS Manual on trucks of Daimler Benz

Aktiengesellschaft, page 8, the selection is complete only when the gear shift lever can be moved farther out of a looked preselected position into position 2, which is present in each direction of shifting. The clutch pedal and the gear shift lever can be released only when the gear selected is shown in the display.

It is recognizable from the Scania brochure titled "Leichter Schalten mit Computern" (Shift more easily by a Computer), page 4, paragraph 1, that a buzzing tone signals to the driver when the selection process is complete and the clutch can be released.

Even though the connection of the feedback for the selection performed in the gearbox to the gear shift lever does provide the driver with information, which comes closest to the information from a gear selector with a shifting linkage, it is bound, as is shown by the examples presented, to the gear shift lever or a comparable gear shifting lever, and involves high cost of construction.

Even though an acoustic signal can be easily realized, it is not particularly suitable as information for the driver, and such signals are burdensome in the case of frequent gear shiftings. In addition, acoustic signals are used as warning signals, whereas the feedback on the selection in a gearbox represents a perfectly normal, but necessary piece of information in the case of servo-assisted selection.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide an improved feedback for the selection performed in the gearbox in a servo-assisted gear selector and, in particular, such that this feedback is bound to a gear selector lever or gear shift lever, and will also not be an acoustic signal.

SUMMARY OF THE INVENTION

This object is achieved, in accordance with the invention by providing the feedback signal as a haptic or tactile signal.

The transmission of a haptic or tactile signal in conjunction with a selection performed in the gearbox to the clutch pedal unmistakably informs the driver that he can again engage a gear. Consequently, he feels the signal at the point at which actuation is to be performed. This tactile signal is not burdensome for the driver, and it also does not represent a distraction for him, as is possible in the case of acoustic or optical signals. The transmission of the hatpic signal is not bound to a gear selector lever or gear shift lever any longer, so that the servo-assisted gear selector can also be used in a simple manner in conjunction with an electronic gear selector, without manual preselection.

Realization is possible electrically in conjunction with, an electromagnet, but also electropneumatically or electrohydraulically, in conjunction with a solenoid valve. The electromagnet can be connected via a short linkage to the clutch pedal, but it may also be arranged directly in the plate of the clutch pedal. The intensity of the haptic or tactile signal can be adjusted in a simple manner via a potentiometer with which the voltage is regulated. The arrangement of a signal generator in the form of an electromagnet in conjunction with a pressure piston which acts on the pressure line between a transducer piston-generator unit at the clutch pedal and a slave piston cylinder unit at the clutch is especially favorable. The pressure signal generated is transmitted

via the transducer piston-cylinder unit and the linkage to the clutch pedal and can be felt at the driver's foot. The signal may also be generated via pressurized media, in which case an electropneumatic 3/2-way valve can release compressed air, after shifting is completed from a pressurized medium source to a signal generator, which generates a pressure shock via a differential piston, and this pressure shock is again transmitted to the clutch pedal via the transducer piston-cylinder unit and a linkage.

BRIEF DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of my invention will become readily apparent from the following description, reference being made to the accompanying highly diagrammatic drawing in which:

FIG. 1 is a connection diagram of an electropneumatic circuit embodying the invention;

FIG. 2 is an enlarged sectional view which an electrical signal generator arranged in the clutch pedal;

FIG. 3 is a connection diagram of a servo-assisted actuating mechanism or a clutch with an electromagnet and a pressure piston as a signal generator; and

FIG. 4 is a diagram of a servo-assisted actuating mechanism for a clutch with an electropneumatic valve and a differential piston unit as a signal generator.

SPECIFIC DESCRIPTION

The connection diagram for an electropneumatic gear selector of FIG. 1 shows a vehicle gearbox 1 with a valve block 11 and three selecting cylinders 12, 13, and 14 for, e.g. three groups of gears. A pressurized medium, e.g. compressed air, is admitted into the valve block in the known manner via a line 15. A gear selector 2 with a range selector 21, an accelerator pedal 3 with a load transducer 31, as well as an optical gear display 4 are connected to an electronic control unit 5 via electrical lines 22, 32, and 42. An electronic tachograph 6 is also connected via lines 61 and 62 to both an electrical pulse generator 16 on the gearbox 1 and the electronic control unit 5, and a clutch pedal 7 is connected via the release switch 71 to said valve block 11 via line 72 and to control device 5 via line 73.

The connection to the vehicle's electrical supply system is designated by reference numeral 65, and an engine brake switch is designated by reference numeral 45.

The electronic control unit 5 is switched to "gear selected" position with the electronic inductive transducer 17 via line 51, with the valve block 11 via line 52, with the switch 18 for the neutral position via line 53, and with the display switch 19 for "gear selected" via line 54.

Yet another signal generator 8 is arranged at the clutch pedal 7; this signal generator 8 receives an electrical signal from the display switch 19 on the gearbox 1 primarily via the electronic control unit 5 and line 55 and transforms it into a haptic signal which is felt by the driver at the clutch pedal 7 when the selection in the gearbox has been completed. A gear can be engaged only after this signal has been perceived. This signal replaces the information on completed selection in a servo-assisted gear selector, which can be felt via the shifting linkage on the gear shift lever in the case of an ordinary manual gear selector or a system which informs the driver of completion of selection by, e.g., optical or acoustic signals in the case of servo-assisted gear selectors.

If said signal generator 8 is an electromagnet, as is shown in FIG. 1, the haptic signal is transmitted via the armature 81 to the clutch pedal 7.

As is shown n FIG. 2. the electromagnet 80 may also be arranged directly in the pedal plate 75, so that the armature 81 can transmit the haptic signal directly or via a transmitting plate 76 to a surface area, e.g. a rubber plate or a rubber profile 77, with which said pedal plate 65 is covered. Because the driver keeps the clutch pedal actuated (clutch pressed down) in this state in which selection in the gearbox has not yet been made or, if the signal arrived it has just been made, he feels this signal in a simple manner without any optical or acoustic nuisance, and he can again release the clutch pedal 7 for engaging. It is also possible to arrange a potentiometer 82 in the electrical line 56 leading to the electromagnet 80 for setting the voltage, because the intensity of the haptic signal can thus be regulated.

FIG. 3 shows the clutch pedal 70 in conjunction with a transducer piston-cylinder unit 9, a line 91 for a pressurized medium, and a slave piston-cylinder unit 95. As is apparent from FIG. 4, the piston of the slave piston-cylinder unit is mechanically connected to the clutch release mechanism 180 of clutch 190 and actuates said clutch. Losses of pressurized medium are compensated for via a container 2 for pressurized medium, and a pressure piston 93 acting on the line 91 for the pressurized medium is actuated via an electromagnet 94 and acts as a signal generator for the haptic signal. The clutch is disengaged during the selection process in the gearbox 1 as a consequence of the clutch pedal 70 being actuated. The actuation takes place over the short linkage 74, the transducer piston-cylinder unit 9, and the pressurized medium, e.g. hydraulic oil in line 91, to the slave piston-cylinder unit 95.

Once the desired gear has been engaged in the gearbox 1, the display switch 19 sends "gear selected" to the electronic control unit 5 via line 54, and the electromagnet 94 is energized by the electronic control unit via electrical line 57. A pressure signal, which is transmitted as a single shock or at intervals to the clutch pedal 70 via the transducer piston-cylinder unit 9 and the linkage 74, is generated in line 91 via the pressure piston 93. The driver feels the pressure signal at his foot and can release the clutch pedal 70, because shifting in the gearbox has been completed. FIG. 4 shows a possibility for generating the haptic signal acting on clutch pedal 700 via a signal generator 10 in conjunction with an electropneumatic 3-part, 2-position valve 120, especially when the pressurized agent for actuating the clutch and the gears is air. As is described in connection with FIG. 3, the 3/2 valve is activated, like the electromagnet 94, after completion of the shifting in the gearbox 1. Pressurized medium is thus sent from a source 110 of pressurized medium via the opened electrical 3/2 valve 120 to the signal generator 10. The actual haptic signal in the pressure line 130 is generated via a differential piston 101 and, as is described in FIG. 3, it is transmitted via the transducer piston-cylinder unit 140 and the linkage 150 to the clutch pedal 700. A pressure reducing valve 160 may also be provided to define the haptic signal. As is described in connection with FIG. 3, line 130 is connected to the actuating piston-cylinder unit 170 for the clutch 190, and piston 171 is connected to the clutch release mechanism 180.

I claim:

1. A gear-selection assembly, comprising:

a vehicle gearbox;

servoassist means operatively connected with said gearbox for shifting gears thereof;

operator-controlled gear-selection means operatively connected to said servoassist means for selecting a gear into which said gearbox is to be shifted;

a clutch pedal depressable by an operator in response to actuation of said operator-controlled gear-selection means to enable shifting of gears by said gear box; and

means responsive to a gearshift performed in said gearbox for generating a haptic signal and applying said signal to said clutch pedal in a form tactilely sensed by said operator while said clutch pedal is depressed, to indicate that said clutch pedal can be released to reengage gears following shifting thereof.

2. A gear-selection assembly, comprising:

a vehicle gearbox;

servoassist means operatively connected with said gearbox for shifting gears thereof;

operator-controlled gear-selection means operatively connected to said servoassist means for selecting a gear into which said gearbox is to be shifted;

a clutch pedal depressable by an operator in response to actuation of said operator-controlled gear-selection means to enable shifting of gears by said gear box; and

means including a signal generator arranged at or on said clutch pedal and responsive to a gearshift performed in said gearbox for generating a haptic signal and applying said signal to said clutch pedal in a form tactilely sensed by said operator while said clutch pedal is depressed, to indicate that said clutch pedal can be released to reengage gears following shifting thereof.

3. The gear-selection assembly defined in claim 2 wherein said signal generator is an electrical signal generator.

4. The gear-selection assembly defined in claim 3 wherein said signal generator includes an electromagnet arranged in a plate of said clutch pedal, and an armature of the electromagnetic acting directly on a cover of the clutch plate.

5. The gear-selection assembly defined in claim 3 wherein said signal generator includes an electromagnet arranged in a plate of said clutch pedal, and an armature of the electromagnet acting on a cover of the clutch plate via a transmission plate.

6. The gear-selection assembly defined in claim 3 wherein said signal generator includes an electromagnet and a potentiometer is connected in circuit with said signal generator for regulating said haptic signal.

7. A gear-selection assembly, comprising:

a vehicle gearbox;

servoassist means operatively connected with said gearbox for shifting gears thereof;

operator-controlled gear-selection means operatively connected to said servoassist means for selecting a gear into which said gearbox is to be shifted;

a clutch pedal depressable by an operator in response to actuation of said operator-controlled gear-selection means to enable shifting of gears by said gear box; and

means including a pressure shock generator responsive to a gearshift performed in said gearbox for generating a haptic signal in the form of a pressure shock and applying said signal to said clutch pedal in a form tactilely sensed by said operator while said clutch pedal is depressed, to indicate that said clutch pedal can be released to reengage gears following shifting thereof.

8. The gear-selection assembly defined in claim 7 wherein said means for generating a haptic signal includes:

a transducer piston-cylinder unit at said clutch pedal and coupled thereto;

a slave piston-cylinder unit at a clutch operated by said pedal;

a pressure line connecting said units;

a pressure piston connected to said pressure line and actuatable to generate a pressure shock therein; and

means for operating said pressure piston to produce said pressure shock whereby said pressure shock is transmitted as said haptic signal to said clutch pedal.

9. The gear-selection assembly defined in claim 7 wherein said means for generating a haptic signal includes:

a transducer piston-cylinder unit at said clutch pedal and coupled thereto;

a slave piston-cylinder unit at a clutch operated by said pedal;

a pressure line connecting said units;

a pressure piston connected to said pressure line and actuatable to generate a pressure shock therein; and

means including an electropneumatic directional control valve for operating said pressure piston to produce said pressure shock whereby said pressure shock is transmitted as said haptic signal to said clutch pedal.

10. The gear-selection assembly defined in claim 9 further comprising an adjustable pressure reducing valve between a source of pressurized medium and said electropneumatic directional control valve.

* * * * *

US006480776B1

(12) **United States Patent**
Stafner

(10) **Patent No.: US 6,480,776 B1**
(45) **Date of Patent: Nov. 12, 2002**

(54) **METHOD AND APPARATUS FOR CONTROLLING AN AUTOMATIC GEARBOX**

(75) Inventor: **Sven Stafner**, Sollentuna (SE)

(73) Assignee: **Scania CV AB (pub)** (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/958,964**

(22) PCT Filed: **Apr. 13, 2000**

(86) PCT No.: **PCT/SE00/00703**

§ 371 (c)(1),
(2), (4) Date: **Oct. 15, 2001**

(87) PCT Pub. No.: **WO00/63592**

PCT Pub. Date: **Oct. 26, 2000**

(30) **Foreign Application Priority Data**

Apr. 16, 1999 (SE) 9901350

(51) **Int. Cl.**[7] **F16H 61/02**
(52) **U.S. Cl.** **701/51**; 701/55; 701/57
(58) **Field of Search** 701/51, 55, 57; 477/98, 120, 121, 900, 902, 903, 904

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Primary Examiner—William A. Cuchlinski, Jr.
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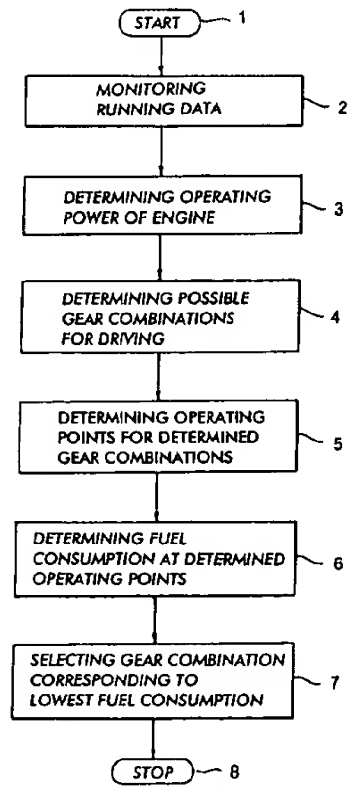
(74) *Attorney, Agent, or Firm*—Ostrolenk, Faber, Gerb & Soffen, LLP

(57) **ABSTRACT**

A process and an arrangement for the control of an automated gearbox. Control is conducted by determining possible gear combinations for driving, determining the operating points for the gear combinations, determining the specific fuel consumption at the operating points, selecting the gear combination with the lowest specific fuel consumption and emitting a command signal for changing to the selected gear combination.

10 Claims, 2 Drawing Sheets



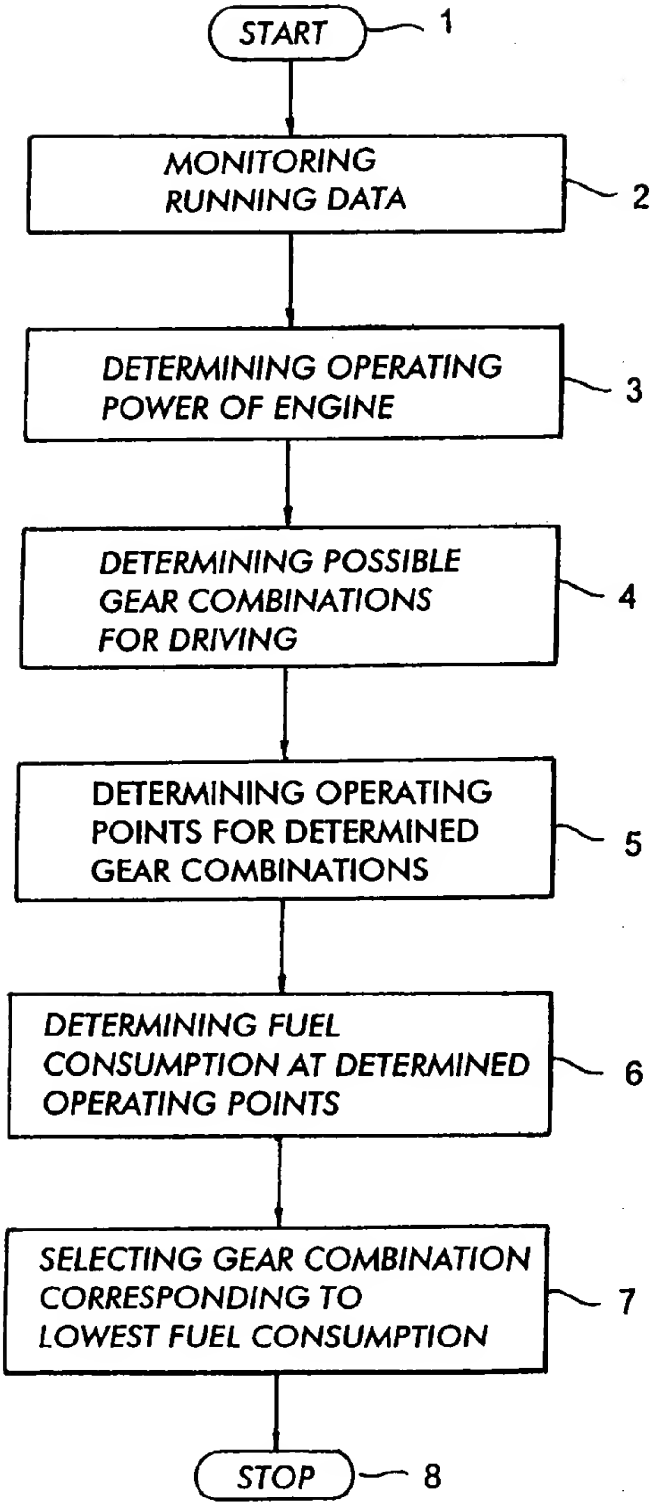

START
1
MONITORING RUNNING DATA
2
DETERMINING OPERATING POWER OF ENGINE
3
DETERMINING POSSIBLE GEAR COMBINATIONS FOR DRIVING
4
DETERMINING OPERATING POINTS FOR DETERMINED GEAR COMBINATIONS
5
DETERMINING FUEL CONSUMPTION AT DETERMINED OPERATING POINTS
6
SELECTING GEAR COMBINATION CORRESPONDING TO LOWEST FUEL CONSUMPTION
7
STOP
8

Fig 1

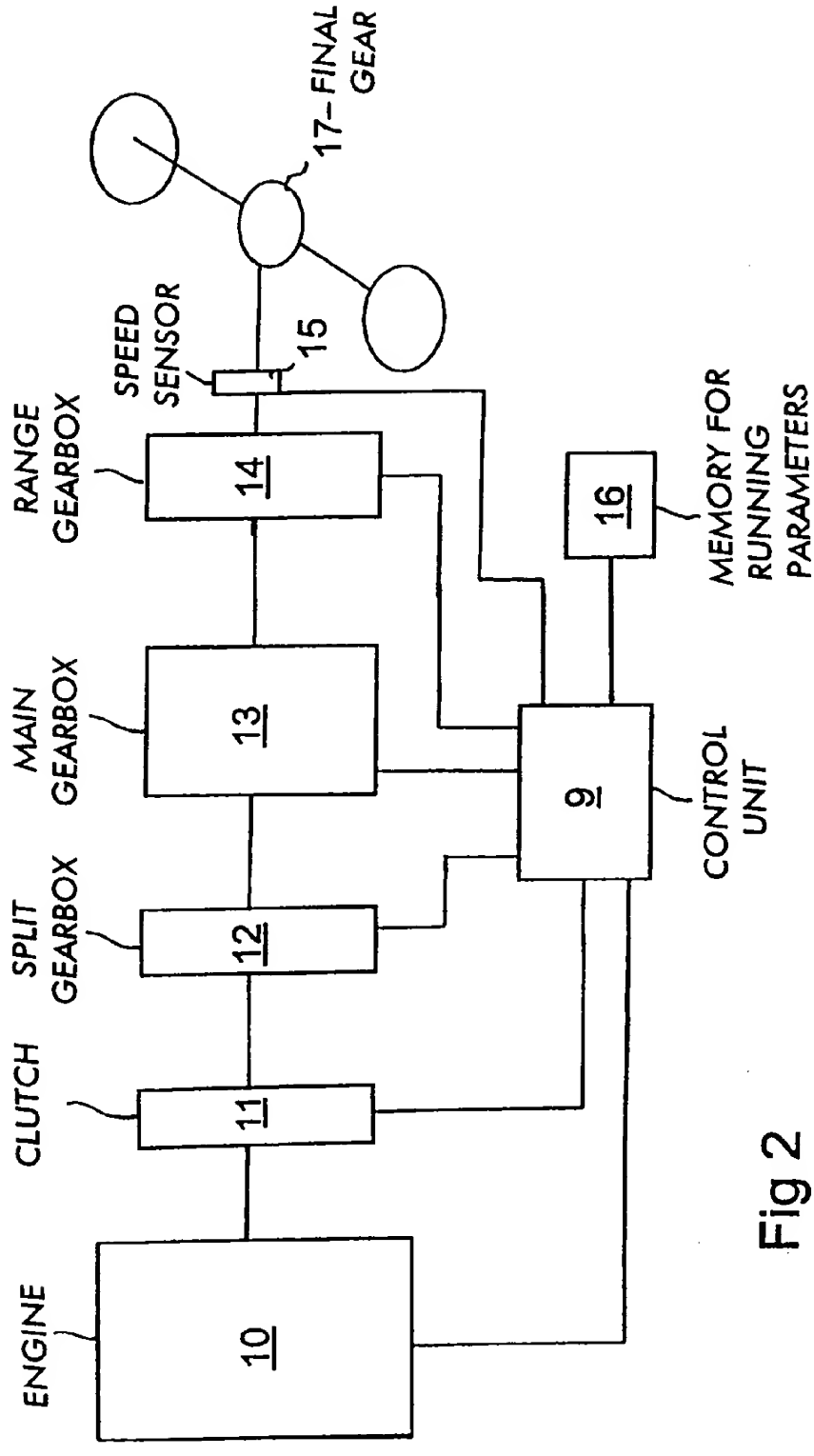

17- FINAL GEAR
15
SPEED SENSOR
RANGE GEARBOX
14
16
MEMORY FOR RUNNING PARAMETERS
MAIN GEARBOX
13
9
CONTROL UNIT
SPLIT GEARBOX
12
CLUTCH
11
ENGINE
10

Fig 2

METHOD AND APPARATUS FOR CONTROLLING AN AUTOMATIC GEARBOX

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a process and an arrangement for control of an automated gearbox. The invention is particularly applicable to mechanical servo-assisted gearboxes for heavy vehicles.

2. Description of the Related Art

Today's gearboxes of this kind are controlled by a control unit which controls gear selection so as to achieve engine operation which is appropriate in the light of experience. This has hitherto involved determining engine reference speeds at which changing up/down is in principle initiated. However, the control unit may also be designed to incorporate in the calculations the vehicle's acceleration and the accelerator pedal position in order to modify the control so that gear changing takes place at an engine speed which may be somewhat lower or somewhat higher than said reference speed. It is also possible for gear changing to be initiated in, for example, two stages instead of one. However, the known system is to be regarded as approximate and no optimisation of operation is possible on vehicles where that system is applied.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to indicate a process and an arrangement for control of an automated gearbox, whereby control is further refined so that the operation of the vehicle can be optimised.

This object is achieved according to the invention by means of the features in the characterising part of patent claims 1 and 5 respectively.

The result is the possibility of selecting in each situation a gear combination which optimises or in practice minimises the vehicle's specific fuel consumption. By means of the invention, various possible and permissible gear alternatives can thus be compared with respect to specific fuel consumption at the operating point concerned so that the latter can be caused to lead to as economic driving as possible.

The process according to the invention involves:

the necessary drive power F being determined on the basis of the calculated running resistance at the prevailing running speed and in the prevailing operating conditions,

possible gear combinations for driving being determined,

possible gear combinations being monitored with respect to torque delivered and permissible engine speed,

the operating points for the possible and permissible gear combinations being determined,

the specific fuel consumption at said operating points being determined,

the gear combination with the lowest specific fuel consumption being selected, and

a command signal for changing to the selective gear being emitted.

The initiation of gear changes which involve one or more gears being skipped is thus not excluded.

A preferred aspect of the invention involves the process being initiated as an economy position after the control unit has, for example, detected that the running speed has for a certain period of time been approximately constant or that the accelerator pedal position has for a certain period of time been below a certain threshold value. This means that the control unit can independently initiate the process sequence, including the economy position, and achieve optimum specific fuel consumption.

Suppressing changes to a new gear combination so that the latter may only be initiated after a certain period of time eliminates excessive gear changing and the driver irritation involved in frequent gear changes.

The invention also relates to a control system suitable for implementing the process. This results in corresponding advantages. Further advantages are achieved as indicated by the following detailed description.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

The invention will now be described in more detail on the basis of an embodiment and with reference to the attached drawings, in which:

FIG. **1** shows a flow diagram of a process according to the invention, and

FIG. **2** illustrates an arrangement according to the invention in connection with the driveline for a heavy vehicle.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. **1**, ref. **1** represents the beginning of the sequence and ref. **2** the monitoring of running data with respect to whether the economy position can be initiated. This entails monitoring, for example, whether the running speed has for a certain period of time been approximately constant, whether the degree to which the accelerator pedal is depressed corresponds to the set-point for the prevailing operating conditions, etc. Ref. **3** represents determination of the necessary drive power on the basis of the calculated running resistance at the prevailing running speed and in the prevailing operating conditions. The running resistance value is preferably updated continuously by evaluation of incoming data concerning the engine, driveline, vehicle, roadway etc. Ref. **4** represents the determination of possible and permissible gear combinations for the prevailing driving situation and ref. **5** represents determination of the operating points for driving with these various gear combinations. Ref. **6** represents determination of the specific fuel consumption at these various operating points, which involves using information which may be derived from a so-called "mussel" diagram which shows the relationship between engine torque and engine speed with respect to the specific fuel consumption of the engine concerned. Ref. **7** represents comparison of the various operating points with respect to specific fuel consumption, resulting in selection of the gear

combination corresponding to the lowest consumption. If the selected gear combination is not the gear combination engaged at the time, the length of the time which has passed since the previous gear change is monitored and if it exceeds a prescribed period of time, signals are transmitted to the relevant components to engage the selected gear combination. Ref. 8 represents the completion of the sequence.

FIG. 2 illustrates schematically an arrangement for control according to the invention, in which ref. 9 represents a control unit which advantageously incorporates devices for control according to the invention which are integrated into or connected to the normal engine control system. Ref. 16 represents a memory for registering running parameters, vehicle weight, running resistance etc. which have to be taken into account in connection with the present invention.

In the driveline, the engine is denoted by **10**, the clutch by **11** and the here triple gearbox by **12**, **13** and **14**, which may represent a division into split, main and range gearboxes. An output speed sensor is denoted by **15** and the final gear by **17**.

The control unit **9** is designed to:

- determine the necessary drive power F on the basis of the calculated running resistance at the prevailing running speed and in the prevailing operating conditions,
- determine possible gear combinations for driving,
- monitor possible gear combinations with respect to torque delivered and permissible engine speed,
- determine the operating points for the possible and permissible gear combinations,
- determine the specific fuel consumption for said operating points,
- select the gear combination with the lowest specific fuel consumption, and
- emit a command signal for changing to the gear selected.

The invention may be varied within the scope of the patent claims set out below. Thus the input data for the calculations may to some extent be varied but should preferably cover running speed, accelerator pedal position, vehicle weight, road gradient, fuel consumption information, gearchange conditions in the gearbox and, where applicable, in the various constituent gearboxes forming part of the gearbox, engine speed and torque curve. Gearchange times may also be incorporated in the calculations, in which case short changing times to certain gear combinations may result in their being preferred.

The process according to the invention, including an economy position, is thus relevant when the vehicle speed is relatively constant, the accelerator pedal is preferably not more than 50% depressed and the engine torque set-value is below a certain specified threshold level. Studies of the driving of heavy vehicles have shown that the economy mode is applicable during as much as 70–80% of running time, which indicates that there is substantial potential for saving which can be utilised by means of the invention, even if the reduction in consumption achieved by means of the invention is not more than a few percent.

EXAMPLE

In one example studied, a vehicle with a total weight of 60 tonnes was driven at a speed of 50 km/h. The gearbox used was a triple gearbox incorporating range, main and split gearboxes, designated SCANIA GRS900. The engine was a SCANIA DSC11413 and the vehicle was driven on a smooth horizontal stretch of road, with the results shown in the following table:

Gear	Engine torque required (Nm)	Engine speed (rpm)	Specific fuel consumption (g/kWh)
8	290	2070	260
9	380	1620	240
10	460	1320	230
11	580	1040	210

In the driving situation described above, gear 11 is selected for optimum fuel economy. If the vehicle had for example been driven in gear 10, the specific fuel consumption would have been about 9% higher. With previously known control systems, the vehicle might very well have been driven in that gear, resulting, in this specific case, in substantially higher fuel consumption for the run.

What is claimed is:

1. A process for the control of an automated gearbox for an engine, the process comprising:

determining operating power of the engine on the basis of a calculated running resistance at a prevailing running speed and in prevailing operating conditions of the engine;

determining possible gear combinations for driving;

monitoring possible gear combinations with respect to torque and speed of the engine;

determining operating points for the possible gear combinations;

determining specific fuel consumption at the operating points;

selecting a gear combination with a lowest specific fuel consumption; and

emitting a command signal for changing to the selected gear combination.

2. The process according to claim **1**, wherein the step of determining specific fuel consumption includes calculating gearchange times for the possible gear combinations.

3. The process according to claim **1**, wherein the running resistance is calculated during operation of the vehicle and on the basis of running data for the vehicle.

4. The process according to claim **1**, wherein the process is initiated as an economy mode after a variation in running parameters of the engine has been below a threshold value for a period of time.

5. The process according to claim **1**, wherein changing from one gear combination to another gear combination may only be initiated after a certain period of time has elapsed.

6. The process according to claim **1**, wherein the vehicle weight is calculated during operation of the vehicle and on the basis of running data for the vehicle.

7. An arrangement for control of an automated gearbox for an engine, the arrangement comprising:

a control unit which is operable to:

determine drive power of the engine on the basis of a calculated running resistance at a prevailing running speed and in prevailing operating conditions of the engine;

determine possible gear combinations for driving;

monitor possible gear combinations with respect to torque delivered and permissible engine speed;

determine operating points for the possible gear combinations;

determine specific fuel consumption for the operating points;

select the gear combination with a lowest specific fuel consumption; and

emit a control signal for changing to the selected gear combination.

8. The arrangement according to claim 7, wherein the control unit is further operable to calculate gearchange times for the possible gear combinations and to incorporate the gearchange times in the determination of the specific fuel consumption.

9. The arrangement according to claim 7, wherein the control unit is operable to calculate, on the basis of running data for a vehicle having the arrangement, the running resistance of the engine during operation.

10. The arrangement according to claim 7,wherein the control unit is operable to calculate, on the basis of running data for a vehicle having the arrangement, the vehicle weight during operation.

* * * * *

United States Patent [19]

Muller et al.

[11] **Patent Number: 4,886,151**

[45] **Date of Patent: Dec. 12, 1989**

[54] **GEARSHIFTING DEVICE FOR A MANUALLY OPERATED TRANSMISSION FOR MOTOR VEHICLES**

[76] Inventors: **Erich R. Muller, Hohe Strasse 15, D-7110 Ohringen-Cappel; Edmund Volkert, Steppachweg 77, D-7107 Neckarsulm, both of Fed. Rep. of Germany**

[21] Appl. No.: **171,181**

[22] Filed: **Mar. 18, 1988**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 907,725, Sep. 15, 1986, abandoned, which is a continuation-in-part of Ser. No. 740,074, May 13, 1985, abandoned.

[30] **Foreign Application Priority Data**

Sep. 14, 1983 [DE] Fed. Rep. of Germany 3333216

[51] **Int. Cl.**[4] **B60K 41/22**; F16H 5/42

[52] **U.S. Cl.** ..... **192/3.62**; 192/3.63; 74/336 R; 74/365

[58] **Field of Search** ..... 192/3.51, 3.54, 3.55, 192/3.58, 3.61, 3.62, 3.63; 74/336 R, 364, 365, 476, 477, 483 R

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Primary Examiner—Leslie A. Braun
Assistant Examiner—Richard M. Lorence
Attorney, Agent, or Firm—Kane, Dalsimer, Sullivan, Kurucz, Levy, Eisele and Richard

[57] **ABSTRACT**

In a gear shifting device for the manual transmission of a motor vehicle with a gearshfit lever, with which the individual gear steps can be engaged over a gearshift rod, the gear shifting motion of the gearshift lever is transferred to the gearshift rod in a nonmechanical manner. The movement of the gearshift lever from the neutral position into the gear shifting position takes place in two steps, the first step acting as a preselection step and the function of the second step being to engage the selected gear step. A locking device permits movement of the gearshift lever from the first into the second step only when the necessary conditions exist for engaging the selected gear step perfectly; that is, when the clutch is disengaged and the gear wheels of the gear steps to be engaged are synchronized.

5 Claims, 2 Drawing Sheets

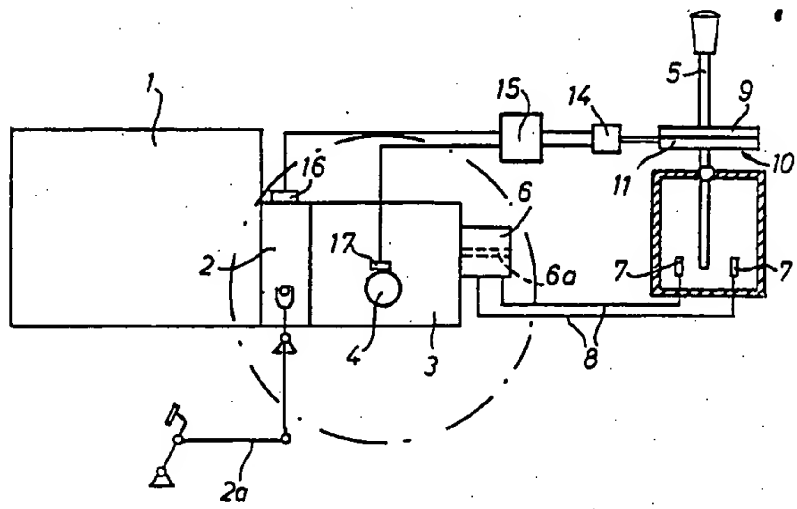


FIG. 1

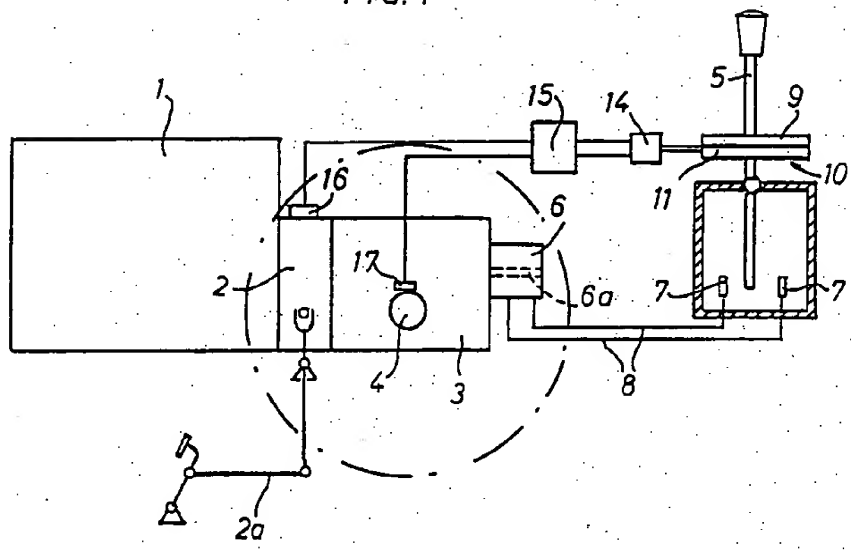
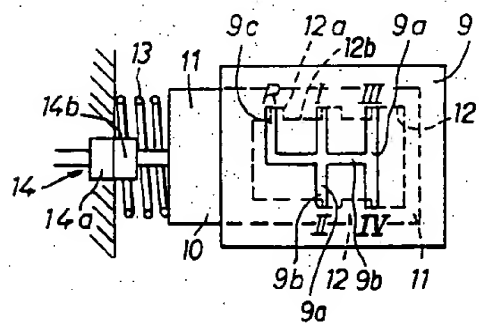


FIG. 2



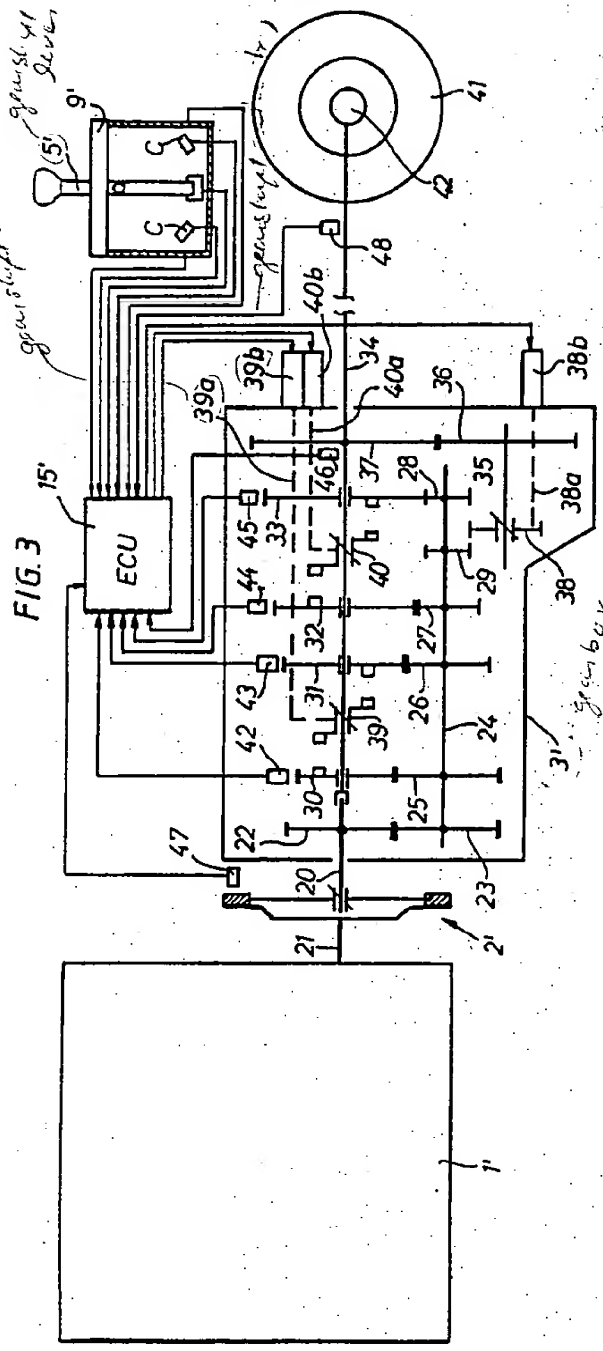


FIG. 3

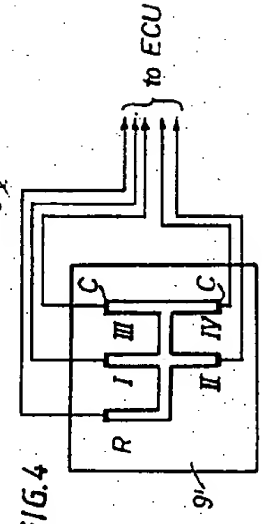


FIG. 4

GEARSHIFTING DEVICE FOR A MANUALLY OPERATED TRANSMISSION FOR MOTOR VEHICLES

The following is a continuation-in-part of U.S. Ser. No. 907,725 filed Sept. 15, 1986, now abandoned which, in turn, is a continuation-in-part of application No. 740,074, filed May 13, 1985, now abandoned.

BACKGROUND OF THE INVENTION

The invention relates to a gear shifting device. The object of the invention is to simplify the engagement of the gear steps without detracting from the gear shifting feel, the gear shifting times and the gear shifting reliability relative to conventional, mechanical gear shifting devices.

SUMMARY OF THE INVENTION

The inventive gear shifting device does without the conventional mechanical transfer of the gear shifting motion from the gearshift lever to the gear shifting rod. As a consequence, the transfer of movements of the transmission to the gearshift lever is avoided and the transfer of body noise from the transmission to the body of the vehicle is reduced. Moreover, the possibility is given, especially if the gear steps are engaged electrically, electro-hydraulically or electropneumatically, of taking into consideration not only the activation of the clutch as a precondition for engaging a gear step, but also other parameters, such as the synchronization of the gearwheels of the gear that is to be engaged, the motion of the vehicle when engaging the reverse gear and optionally other engine components.

The invention is also usable for transmissions, in which, instead of the gear rod, a device is provided which is activated electrically, pneumatically or hydraulically to engage each step.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic representation of a motor vehicle driving mechanism.

FIG. 2 shows a gear shifting gate for a gearshift lever.

FIG. 3 is a schematic representation of a 4-speed transmission and its controls.

FIG. 4 is a view of the gearshift gate of the gearshift lever.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The vehicle engine, labeled 1 in FIG. 1, drives the driveshaft 4 of the vehicle over a disengageable clutch 2 and a mechanical gearbox 3. Clutch 2 is actuated by clutch actuating mechanism 2*a*. The gear steps of the mechanical gearbox 3 are engaged by a gearshift lever 5, which activates over an electric, hydrcaulic or pneumatic switching device 6 the pivoted movable gearshift rod 6*a* in the mechanical gearshift 3. The switching device 6 is provided with the appropriate facilities, such as rotary magnet (not shown) in order to shift and rotate the gearshift rod in correspondence with the gear step selected. The switching device 6 receives the appropriate signals by electrical means through contacts 7, which are activated by gearshift lever 5 and are connected through wiring 8 with the switching device 6. In FIG. 1, only the contact assigned to the first and second gear are shown. Obviously, appropriate contacts are assigned to the remaining gear steps and the gearshift lever 5 can act on these through its motion, which is specified by the gear shifting gate. Gear shifting gate 9 includes transverse slot 9*a* defining gear shift lanes for forward gears I–II and III–IV, a transverse slot 9*c* for reverse and longitudinal slot 9*b* interconnecting slot 9*a* and 9*c*.

In order to make it possible to engage a gear only when the clutch 2 is disengaged, a locking device 10 is provided, which prevents the gearshift lever 5 reaching and end position that defined by the end of the respective slot 9*a* or 9*c* activates the appropriate contact 7, when the clutch is not disengaged completely. In the example of the operation, this locking device consists of plate 11, which is movably arranged below the gear shifting gate 9 and which has slots 12 for forward gears and slot 12*a* for reverse, similar to those of the gear shifting gate 9. As can be seen from FIG. 2, these slots 12 and 12*a* are interconnected by a longitudinal slot 12*b* having a width wider than the width of longitudinal slot 9*b* and gear shifting gate 9. Therefore, the slots 12 and 12*a* are somewhat shorter than the corresponding slots 9*a* and 9*c* in the gear shifting gate 9, so that in the position of plate 11 shown in FIG. 2 the gearshift lever 5 can admittedly be introduced into the appropriate gear shifting lane, but cannot be guided to its end position, in which its activates the appropriate contact 7. Only when plate 11 was displaced so far to the left in FIG. 2 against the action of a spring 13 that the slots 12 coincide with the slots 9*a* in the gear shifting gate 9, can gearshift lever 5 be brought into its end position for enaging one of the gears. This displacement of plate 11 is accomplished with the help of an electromagnet 14 having two coils 14*a* and 14*b*, which is activated by an electric control device 15. The control device 15 is connected to a sensor 16, which gives a signal when the clutch is fully disengaged and induces the control device 15 to energize the electromagnet 14*a*, so that the latter displaces plate 11 and sets free the path for the gearshift lever 5 by aligning slots 12 with slots 9*a* and 9*c* and slot 12*a* with slot 9*c* so that any of years I, II, III, IV and R can be shifted. A further sensor 17 detects the direction of rotation of the driveshaft 4 and supplies an appropriate signal to the control device 15, so that engaging the reverse gear is prevented as long as the driveshaft is turning in the forward driving direction. Thus, according to the embodiment shown, when sensor 17 detects that the drive shaft turns in the forward direction coil 14*b* is energized so that plate 11 is shifted to the left for an additional amount into a position in which the slots 9*c* and 12*a* do not coincide so that the reverse gear can not be shifted. With plate 11 in this position it is possible to shift into a forward gear only.

FIGS. 3 and 4 show a complete 4-speed gearbox with a reverse gear of conventional design. The input shaft 20 of gearbox 3 is connected through disengageable clutch 2 with the output shaft 21 of engine 1. A gear 22 on input shaft 20 is in mesh with a gear 23 fast on an intermediate shaft 24. Fast on intermediate shaft 24 are the gears 25, 26, 27 and 28 for the 1st, 2nd, 3rd and 4th forward gear step and the gear 29 for the reverse gear. Gears 25, 26, 27 and 28 are in mesh with gears 30, 31, 32 and 33, respectively, which are loose on the output shaft 34 of gearbox 3. A reverse gearshift 35 carries a gear 36 which is in mesh with a gear 38 fast on the output shaft 34. A further gear 38 is non-rotatably but shiftably arranged on reverse gearshift 35 and can be brought into and out of engagement with gear 29 on the intermediate shaft 24. The output shaft 34 carries gearshift collars 39

and 40 which are non-rotatably arranged on output shaft 34 but can be shifted from the neutral position shown in either direction to couple one or the other of the adjacent gears 30, 31 or 32, 33 with the output shaft 34. Collary 39 is connected through a gearshift rod 39*a* with a gearshift actuator 39*b*, and collar 40 is connected through a gearshift rod 40*a* to a gearshift actuator 40*b*. Furthermore the reverse shift gear 38 is connected through a gearshift rod 39*a* to a further gearshift actuator 38*b*. The output shaft 34 is connected to a differential gear 40 to drive wheels 41.

A gearshift lever 5' is arranged for shifting in a gate 9' which has the usual lanes or slots for the individual gears, namely forward gears I, II, III, IV and the reverse gear R. At the end of each slot there is a contact 7 which is engaged by the gearshift lever 5' when it is moved in the corresponding slot. The signal for the gear step to be engaged is fed to an electrical control unit 15' ("ECU 15"). In addition, the control unit 15' receives signals from sensors 42, 43, 44 and 45 which sense the speed of the gears 30, 31, 32 and 33, respectively; a signal from sensor 46 which senses the speed of the output shaft 34; a signal from sensor 47 which gives a signal whe the clutch is disengaged; and a signal from sensor 48 when the output shaft 34 is not rotating in forward direction. Sensors 46 and 48 could be combined.

The operation is as follows:

When the driver wishes to change gears he actuates the clutch actuating mechanism 2*a* in FIG. 1 whereby the clutch 2' is disengaged, and sensor 47 gives a corresponding signal to ECU 15' that clutch 2' is disengaged. When the driver shifts the gearshift lever 5' into the appropriate lane, the contact 7 of the intended gear step is activated and a corresponding signal is fed to ECU 15'. ECU 15' compares the speed of the gear of the selected gear step; i.e., the speed of one of the gears 30, 31, 32 or 33 detected by the associated sensor 42, 43, 44 or 45 with the speed of the output shaft 34, and if there is synchronization, an appropriate output signal is fed from ECU 15' to the respective gearshift actuator 39*b* or 40*b* to shift gearshift rod 39*a* or 40*a* and therewith gearshift collar 39 or 40 to couple the selected gear 30, 31, 32 or 33 with the output shaft 34. If, for instance, the 2nd gear is selected, the collar 31 is shifted to the right so that gear 31 is coupled with output shaft 34.

If the driver selects reverse gear, he shifts gearshift lever 5' into the R-slot of gate 9' closing the respective contact 7 whereby a signal is fed to ECU 15'. If ECU 15' has received signals from sensors 47 and 48 showing that clutch 2' is disengaged and output shaft 34 is not turning in forward direction, an output signal is fed from ECU 15' to gearshift actuator 38*b* to shift gearshift rod 38*a* to the left and bringing gear 38 in mesh with gear 29.

The gearshift actuators are preferably hydraulically operated double-acting pistons, the flow of fluid to either side thereof being controlled by electric valves actuated by the signals of ECU 15'. If gearshift lever 5' is returned to its neutral position there is no signal from any of the contacts 7 to ECU 15' and therefore the output signal from ECU 15' ceases and the respective piston returns to its neutral (intermediate) position, and the connection between the respective gear 30, 31, 32 or 33 and output shaft 34 is interrupted.

The invention is not limited to the example of the operation shown. The forces and paths of the switching device 6 can also be generated over hydomechanical or pneumatic structural elements, which are acted upon by existing hydraulic or air pumps. Instead of a gearshift rod for engaging individual gears, electric, pneumatic or hydraulic devices can be assigned to each gear step. These devices are activated by the gearshift lever 5 basically in the same manner described above in connection with the activations of a gearshift rod. Additional sensors may also be provided with determine, for example, the synchronization of the wheels of the gear to be engaged, and give appropriate signals to the control device.

What is claimed is:

1. A gear shifting device for a manually operated transmission for a motor vehicle having wheels driven through said transmission, said transmission having an input shaft connected through a disengageable clutch with a vehicle engine, an output shaft connected to the driven wheels and several gear steps between said input and output shafts; each gear step comprising two intermeshing gears, one of them being fast on an intermediate shaft driven by said input shaft and the other being loosely mounted on said output shaft, and means for engaging and disengaging said gear steps in communication with a gearshift lever which can be moved form a neutral position into a gear shifting position, the movement taking place in two steps—the first step being a preselection step for selecting a gear step and the second step acting to engage the selected gear step; a number of contacts, one for each gear step, to be engaged by the gearshift lever at the end of the second step according to the selected gear step; a locking device which permits movement of the gearshift lever from the first into the second step only when the clutch is disengaged; first sensing means for sensing the speed of each gear on the output shaft and second sensing means for sensing the speed of the output shaft; means for comparing the speeds of the gear selected and the output shaft; means for generating a first output signal if the speeds sensed are synchronized; a third sensing means generating a second output signal when the clutch is disengaged; and means for releasing said locking device upon receipt of said second output signal so that the gearshift lever can be moved from the first into the second step to activate the means for engaging and disengaging gear steps for the selected gear step upon generation of said first output signals.

2. A gear shifting device according to claim 1 for transmission with a reverse gear, and further comprising a sensor which detects the direction of rotation of the output shaft and actuates the means for releasing the locking device to permit the gearshift lever to engage the reverse gear only if the output shaft is not turning in a direction to drive the motor vehicle forwardly.

3. A gear shifting device for a manually operated transmission for a motor vehicle having wheels driven through said transmission, said transmission having an input shaft connected through a disengageable clutch with a vehicle engine, an output shaft connected to the driven wheels and several gear steps between said input and output shafts; each gear step comprising two intermeshing gears, one of them being fast on an intermediate shaft driven by said input shaft and the other being loose on said output shaft, and a gearshift collar associated with the other of said gears and non-rotatably but shiftably arranged on the output shaft; means for shifting said collar into and out of engagement with said other gear; a gearshift lever which can be moved from a neutral position into a gear shifting position, the move-

ment taking place in two steps, the first step being a preselection step for selecting a gear step and the second step acting to engage the selected gear step; a number of contacts, one for each geat step, to be engaged by the gearshift lever at the end of the second step according to the selected gear step; a locking device which permits movement of the gearshift lever from the first into the second step only when the clutch is disengaged; first sensors, one for each other gear of each gear step for sensing the speed thereof; a second sensor for sensing the speed of the output shaft; means for comparing the speed of the gear selected and sensed by the appropriate said first sensor with the speed sensed by said second sensor; means for generating a first output signal if the speed sensed by that first sensor associated with the other gear of the selected gear step equals the speed sensed by the second sensor; a third sensor generating a second output signal when the clutch is disengaged; and means for releasing said locking device upon receipt of said second output signal when the clutch is disengaged; and means for releasing said locking device upon receipt of said second output signal so that the gearshift lever can be moved from the first into the second step to activate shift actuator means for the selected gear step, said shift actuator means shifting said collar into engagement with the other gear of the selected gear step upon generation of said first output signal.

4. A gear shifting device according to claim 3, wherein said transmission comprises a reverse gear and means for bringing the reverse gear in engagement with a gear which is in positive driving connection with the input shaft, and further comprising a fourth sensor for detecting the direction of rotation of said output shaft and generating a signal when said output shaft is not turning in a forward direction, said signal being fed to an electrical control unit to activate the means for shifting the reverse gear only upon receipt of said signal, of a signal from the gear selector means after selection of the reverse gear and of a signal from the third sensor indicating disengagement of said clutch.

5. A gear shifting device according to claim 4, wherein the means for shifting each collar and the reverse gear comprise a gearshift rod and an actuator for shifting said rods in accordance with the output signals from said electrical control unit.

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